Research Design
Maj Ricardo Colón – Vigilance Horizons

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Working Title

Human-Machine Teaming in Intelligence Analysis: An Information Age Answer to the Manpower Problem

Research Problem

The continuous drive to introduce or improve intelligence, surveillance, and reconnaissance sensors inevitably leads to a rapidly growing data pool of increasingly higher fidelity. This trend is projected to overwhelm the USAF processing, exploitation, and dissemination (PED) enterprise responsible for its analysis, which is heavily dependent on human operators. As the data pool continues to expand, the capacity for sufficient human analysis dwindles, and previously employed tactics to simply add more manpower are no longer effective or sustainable. How can the USAF PED enterprise employ Artificial Intelligence (AI) to address an ever-increasing gap between requirements and manpower?

Thesis Statement

The introduction of AI technologies will fundamentally change the way the USAF PED enterprise tasks and executes missions. The USAF should adopt a multi-pronged approach focused on deliberately shaping tasking and execution constructs to maximize operational efficiency and address the growing gap between requirements and manpower.

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Background and Significance

On April 26, 2017, Deputy Secretary of Defense Robert Work signed a memo directing the Department of Defense to "integrate artificial intelligence and machine learning more effectively across operations to maintain advantages over increasingly capable adversaries and competitors."[1] In the memo, he established the Algorithmic Warfare Cross-Functional Team (AWCFT) to establish a framework for turning massive amounts of data into "actionable intelligence and insights at speed."[2] The AWCFT is in the process of carrying out this directive, and its first task is to find ways to employ AI in order to reduce the human workload associated with PED.

While AI technologies are still maturing, the areas offering the most promise for the PED enterprise are computer vision, natural language processing, machine translation, and trend projection, with machine learning underpinning each of those technologies. Current efforts are primarily focused on integrating computer vision technologies into PED of full motion video (FMV). A fielded computer vision solution would identify vehicles, equipment, or personnel within an image and continuously refine its algorithm in response to a human analyst's validation or rejection of its assessments. Along the same lines, natural language processing and machine translation are poised to eventually play a prominent role in transcription and translation of intercepted communications, tasks that currently require a sizeable force of highly-trained analysts. Finally, trend projection will enable managers to more accurately predict PED workload, optimally aligning crews against specific requirements at the appropriate times.

How do these advances in AI technology translate to tangible results on the PED operations floor? A core principle underpinning the prevailing interest in AI is its ability to take over tasks currently executed by humans and the prospect for a corresponding dividend in

manpower savings. Colonel Drew Cukor, Chief of the AWCFT stated, "Eventually we hope that one analyst will be able to do twice as much work, potentially three times as much, as they're doing now."[3] This proposition is contingent upon effective human-machine teaming (HMT), a construct where machines complement human work. If integrated appropriately, HMT will enable one person to analyze more data at a faster pace with fewer errors, improving both the effectiveness and efficiency of the analytic process.

Problem Analysis

This research intends to explore what the proposed HMT concept looks like when applied in the trenches of the PED enterprise, with particular focus on the tasking and execution phases. Using the Distributed Common Ground System (DCGS) as a point of reference, HMT would have significant implications on PED execution, manifesting in altered crew constructs and modified positional responsibilities for each operator. How does this reverberate across the crew construct generally employed in PED of airborne ISR? Fervent advocates of AI incessantly emphasize its ability to downsize the workforce in the private sector, but how do such projections translate to PED crews? Does this new technology present opportunities to merge or eliminate crew positions? What manpower savings can HMT reasonably be expected to generate and under what time horizon?

Moreover, second and third order implications of AI integration in the PED enterprise have the potential to revolutionize the PED tasking paradigm and return manpower dividends. As first-phase machine exploitation continues to mature and improve, what are the prospects of detaching crews from tails while airborne? The current tasking and execution construct requires operators to conduct analysis while the mission is ongoing. AI technologies, however, may eventually provide an opportunity to detach crews from tails while the machine conducts first-

phase exploitation. This would enable analysts to maximize their efficiency by eliminating the need to observe periods of inactivity, which are often quite numerous and lengthy. What is the risk/reward ratio of delegating first-phase exploitation of some ISR data to machines? How would humans integrate in such a construct, and what are the impacts on manpower requirements?

Research Methodology

This research project will employ a qualitative approach, using case studies, historical evidence, academic literature, and interviews to arrive at conclusions and recommendations. Since extensive academic research on the nexus between AI and PED is lacking, my research will include both primary and secondary sources.

The breadth of the research problem requires the imposition of several constraints so that we may arrive at a manageable scope. In order to properly articulate the implications of AI on PED, I have to assess what a future AI-enabled PED enterprise looks like, and that requires some assumptions. I will constrain my assessment to those AI technologies that can reasonably be fielded within the next five years. Given AI's rapid development, an outlook beyond five years is too nebulous to be of practical value for the purpose of this study. I will also constrain my definition of the PED enterprise to include only crew-based exploitation teams such as those associated with PED of airborne ISR—DCGS, Rivet Joint, and JSTARS. However, many of the lessons learned and conclusions drawn will likely be applicable to non-crew PED elements as well.

I intend to devote significant effort to establish a baseline understanding of the current state of artificial intelligence in the private sector, as such awareness is necessary to identify

opportunities for the PED enterprise. My review of the current academic literature on AI revealed a large number of recent articles detailing progress in the field. I intend to examine these articles to establish terminology, identify prevailing trends in industry, and explore connections between private sector and military applications.

As previously mentioned, a key assumption in this research involves the identification of AI technology that is expected to be fielded in the PED enterprise within the next five years. My primary efforts on this front will focus on identifying the current priorities and lines of effort at AWCFT to estimate what this future PED enterprise looks like. Moreover, I intend to consult academic literature and magazines to assess the state of technology in the particular areas of AI that appear most promising for PED—computer vision, natural language processing, machine translation, trend projection, and machine learning.

Identifying implications associated with the integration of AI technology in the PED enterprise will be largely speculative. However, I intend to enhance the reliability of my assessment by employing a multi-pronged approach. First, I will review private sector reports and case studies documenting the impact of AI on various companies, paying particular attention to its impact on human resources. Second, I will examine the introduction of information technology into the private sector and military as a comparative case study of similarly disruptive technology. Finally, I expect to derive considerable insight by consulting the current operating procedures of operational PED units, particularly the DCGS enterprise, which I intend to examine as a representative crew-based PED element for the purposes of this study. This portion of the research will largely revolve around review of operational instructions, checklists, and interviews with analysts and managers. Combining these varied sources will enable me to predict

with some level of confidence how various AI technologies will impact the tasking and execution processes, which ultimately drive manpower requirements.

Hypothesis & Expected Findings

While current efforts are focused primarily on integrating AI technologies to complement the work of front-line analysts, I hypothesize that a multi-pronged, parallel approach exploiting both the tasking and execution constructs will prove most fruitful in addressing the growing gap between requirements and manpower. If AI technologies are effectively applied to PED tasking and execution, they have the potential to change the way we think about the entire enterprise, enabling a construct that pairs humans with machines and blurs the lines between different PED organizations. As data becomes more accessible and information is compiled more quickly and accurately, the enterprise naturally flattens. It follows that the way we task and execute PED should follow suit and shift away from the hierarchical structures currently in place. These projected consequences must be carefully examined and exploited to maximize return on investment and derive manpower savings.

AI will inevitably change the way front-line analysts currently execute their craft. Advances in computer vision, natural language processing, and machine learning will eventually drive the transition of routine tasks from humans to machines. At the crew level, this means responsibilities will be shifted between different crew positions and may eventually shrink crew size and enable analysts to review more data. However, if lessons learned from the integration of previous disruptive technologies such as computers hold true, the more likely outcome is that analyst responsibilities will shift to functions more suited for human execution, such as interdisciplinary problem solving.

Moreover, machine exploitation will open doors that have heretofore remained closed or undiscovered. Once the algorithms are mature enough to reliably and consistently produce results as good or better than human analysts, machines may be delegated responsibility for first-phase exploitation of low-priority missions. Human partners would then rely on alerts generated by the machine to review and validate assessments. Such a construct would optimize a human-machine partnership and ensure that all collected data received some measure of analysis. This construct would be particularly well-suited for missions producing exceptionally large amounts of data such as Wide Area Aerial Surveillance, where a large portion of collected data is never viewed by anyone. If we take this a step further and build an architecture that centralizes all collected data for easy access across the PED enterprise, AI technologies open the potential for an organization-agnostic construct in which PED organizations collaborate to meet growing requirements.

Outline

- Introduction
    - Background and significance of problem
        - Establish premise: Rising requirements/steady manpower
    - Thesis Statement
    - Scope
        - Limited to next 5 years
        - Limited to PED of airborne ISR (w/ focus on DCGS)
        - Limited to narrow AI technologies
- AI Applications for USAF PED
    - Machine Learning
    - Computer Vision
    - Natural Language Processing
    - Machine Translation
    - Trend Projection
- Implications of AI Employment on USAF PED
    - Tasking
        - First-phase machine exploitation
        - "Alert"-based tasking
    - Execution
        - Crew construct

        - Positional responsibilities
        - Tied to tail?
- Recommendations (TBD—below is a prediction)
    - Invest in cloud-based infrastructure and "big data" software
    - Employ organization-agnostic PED construct for some missions
        - "Alert"-based exploitation
        - Execute low-risk proof-of-concept
            - Wide Area Aerial Surveillance (WAAS)
            - MQ-1/9 ingress and egress scans
- Conclusion

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Endnotes

[1] Deputy Secretary of Defense Robert Work, memorandum, April 26, 2017, Office of the Deputy Secretary of Defense, "Establishment of an Algorithmic Warfare Cross-Functional Team (Project Maven)"
[2] Work, "Establishment of AWCFT."
[3] Cherryl Pellerin, "Project Maven to deploy computer algorithms to war zone by year's end," DoD, 21 Jul 17, https://www.defense.gov/News/Article/Article/1254719/project-maven-to-deploy-computer-algorithms-to-war-zone-by-years-end/